ANNUAL REPORT
to the
GOVERNMENTS
of
THE UNITED STATES and CANADA

COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD

Washington, D.C. Ottawa, Ontario

30 SEPTEMBER 1963

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

CANADA · UNITED STATES

CANADIAN SECTION
G.M. MacNABB, Chairman
R.L. Dalon, Member

UNITED STATES SECTION
L.A. DUSCHA, Chairman
R.H. Wilkerson, Member

31 December 1988

The Honorable George P. Shultz
The Secretary of State
Washington, D.

The Honourable Marcel Masse
Minister of Energy, Mines and Resources
Ottawa, Ontario

Gentlemen:

Reference is made to the Treaty between the United States of America and Canada, relating to co-operative development of the water resources of the Columbia River basin, signed at Washington, D.C., on 17 January 1961.

In accordance with the provisions of Article XV paragraph 2(e), there is submitted herewith the twenty-fourth Annual Report, dated 30 September 1988, of the Permanent Engineering Board.

The report sets forth results achieved and benefits produced under the Treaty for the period from 1 October 1987 to 30 September 1988.

Respectfully submitted:

For the United States

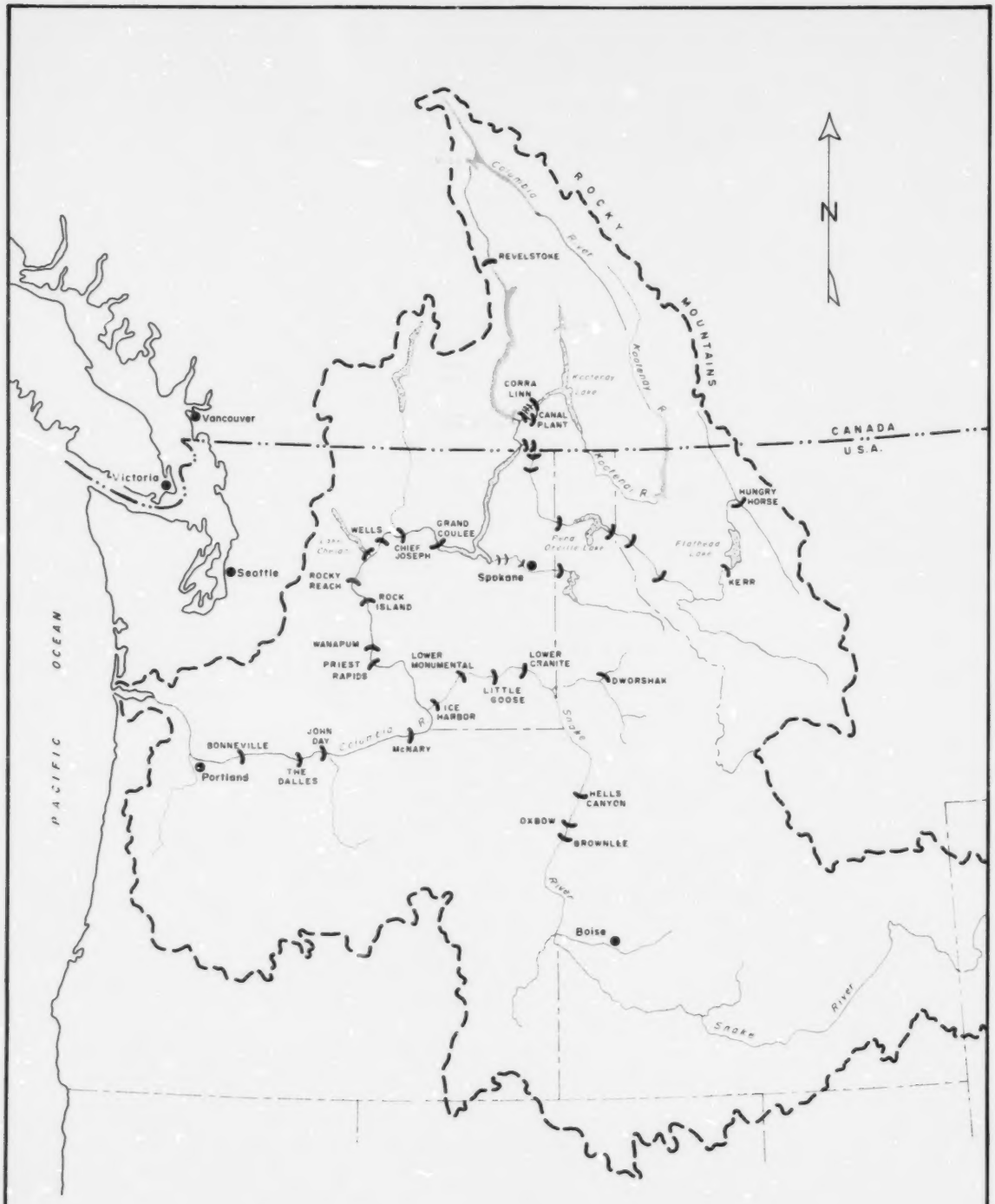
Lloyd A. Duscha, Chairman

Ronald H. Wilkerson

For Canada

G.M. MacNabb, Chairman

R.L. Dalon



COLUMBIA RIVER BASIN

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90-00886/

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Photographs supplied by the British Columbia Hydro and Power Authority, the Government of British Columbia, and the U.S. Army Corps of Engineers.

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SUMMARY

The twenty-fourth Annual Report of the Permanent Engineering Board is submitted to the Governments of the United States and Canada in compliance with Article XV of the Columbia River Treaty of 17 January 1961. The status of projects, progress of Entity studies, operation of Duncan, Arrow, Mica and Libby reservoirs, and the resulting benefits are described.

The Duncan, Arrow, Mica and Libby storage projects were operated throughout the year in accordance with the objectives of the Treaty and the terms of operating plans developed by the Entities. Operations under an agreement between the Entities relating to the use of non-Treaty storage and refill enhancement for Mica and Arrow reservoirs did not conflict with Treaty operations. As a result of low natural flows in the basin, Treaty reservoirs were not required to be operated for flood control purposes during the year. (Pages 26-33)

Studies pertaining to development of the hydrometeorological network and power operating plans are being continued by the Entities to ensure operation of projects in accordance with the terms of the Treaty.

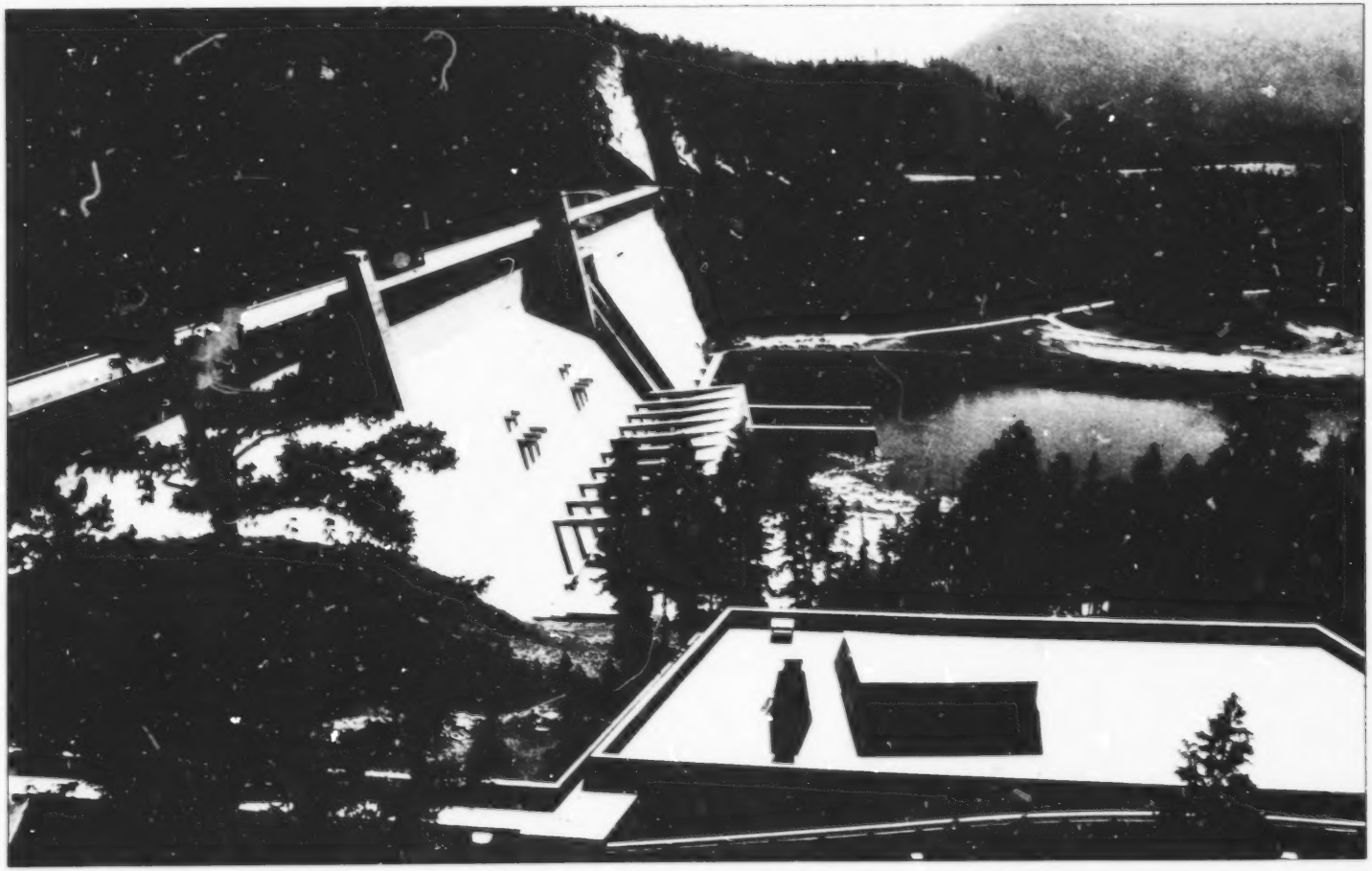
During the report year, the Entities signed two agreements relating to changes in procedures for developing assured operating plans and determining downstream power benefits. These agreements have resolved concerns which the Board has expressed in recent annual reports. The agreements have allowed the Entities to complete the 1992-93 Assured Operating Plan and Determination of Downstream Power Benefits. The corresponding documents for 1993-94 should be received in March 1989. Subsequent delays are not expected. (Pages 21-24)

The Board concludes that the objectives of the Treaty are being met.

INTRODUCTION

The Columbia River Treaty, which provides for cooperative development of the water resources of the Columbia River basin, was signed in Washington, D.C. on 17 January 1961 by representatives of the United States and Canada. Article XV of the Treaty established a Permanent Engineering Board and specified that one of its duties would be to "make reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty . . ."

This Annual Report, which covers the period 1 October 1987 to 30 September 1988, describes activities of the Board, progress being achieved by both countries under the terms of the Treaty, operation of the Treaty projects, and the resulting benefits. Summaries of the essential features of the Treaty and of the responsibilities of the Board and of the Entities are included. The report notes that the Entities concluded studies of several issues affecting the operation and benefits under the Treaty. Based on these studies, the Entities reached two major agreements relating to principles of operation and to changes to the procedures for the Preparation of Assured Operating Plans and Determination of Downstream Power Benefits. The report provides discussion regarding the operations of the Treaty reservoirs and of the resulting power and flood control benefits, and presents the conclusions of the Board.



LIBBY DAM Kootenai River, Montana
The dam and powerhouse, showing the visitor's centre in foreground.

THE COLUMBIA RIVER TREATY

General

The Columbia River Treaty was signed in Washington, D.C. on 17 January 1961 and was ratified by the United States Senate in March of that year. In Canada ratification was delayed. Further negotiations between the two countries resulted in formal agreement by an exchange of notes on 22 January 1964 to a Protocol to the Treaty and to an Attachment Relating to Terms of Sale. The Treaty and related documents were approved by the Canadian Parliament in June 1964.

The Canadian Entitlement Purchase Agreement was signed on 13 August 1964. Under the terms of this agreement Canada's share of downstream power benefits resulting from the first thirty years of scheduled operation of each of the storage projects was sold to a group of electric utilities in the United States known as the Columbia Storage Power Exchange.

On 16 September 1964 the Treaty and Protocol were formally ratified by an exchange of notes between the two governments. The sum of $253.9 million (U.S. funds) was delivered to the Canadian representatives as payment in advance for the Canadian entitlement to downstream power benefits during the period of the Purchase Agreement. On the same date at a ceremony at the Peace Arch Park on the International Boundary the Treaty and its Protocol were proclaimed by President Johnson, Prime Minister Pearson, and Premier Bennett of British Columbia.

Features of the Treaty and Related Documents

The essential undertakings of the Treaty are as follows:

(a) Canada will provide 15.5 million acre-feet of usable storage by constructing dams near Mica Creek, the outlet of Arrow Lakes and Duncan Lake, in British Columbia.

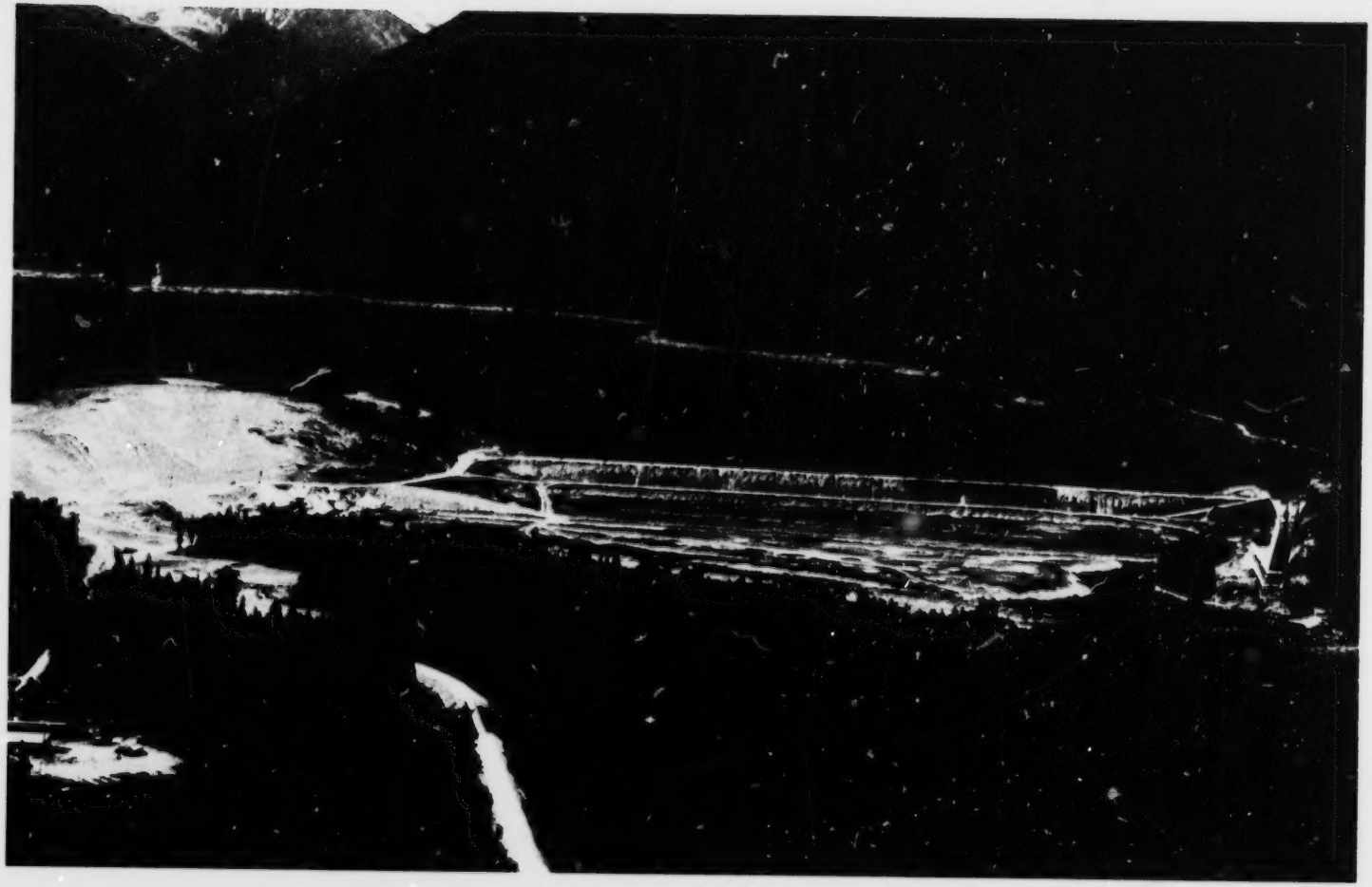
(b) The United States will maintain and operate hydroelectric power facilities included in the base system and any new main-stem projects to make the most effective use of improved streamflow resulting from operation of the Canadian storage. Canada will operate the storage in accordance with procedures and operating plans specified in the Treaty.

(c) The United States and Canada will share equally the additional power generated in the United States as a result of river regulation by upstream storage in Canada.

(d) On commencement of the respective storage operations the United States will make payments to Canada totalling $64.4 million (U.S. funds) for flood control provided by Canada.

(e) The United States has the option of constructing a dam on the Kootenai River near Libby, Montana. The Libby reservoir would extend some 42 miles into Canada and Canada would make the necessary Canadian land available for flooding.

(f) Both Canada and the United States have the right to make diversions of water for consumptive uses and, in addition, after September 1984 Canada has the option of making for power purposes specific diversions of the Kootenay River into the headwaters of the Columbia River.



DUNCAN DAM
The earth dam with discharge tunnels to the left and spillway to the right.

Duncan River, British Columbia

(g) Differences arising under the Treaty which cannot be resolved by the two countries may be referred by either to the International Joint Commission or to arbitration by an appropriate tribunal as specified by the Treaty.

(h) The Treaty shall remain in force for at least 60 years from its date of ratification, 16 September 1964.

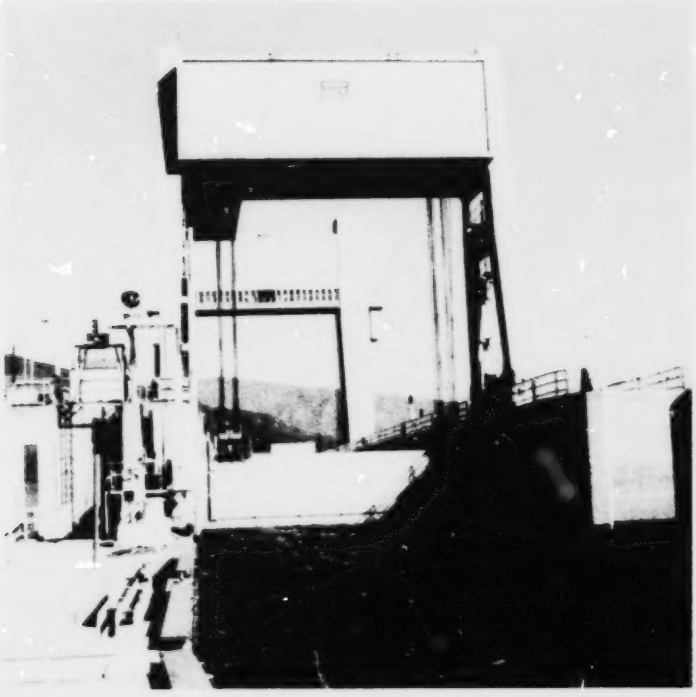
The Protocol of January 1964 amplified and clarified certain terms of the Columbia River Treaty. The Attachment Relating to Terms of Sale signed on the same date established agreement that under certain terms Canada would sell in the United States its entitlement to downstream power benefits for a 30-year period. The Canadian Entitlement Purchase Agreement of 13 August 1964 provided that the Treaty storages would be operative for power purposes on the following dates:

Duncan storage	1 April 1968
Arrow storage	1 April 1969
Mica storage	1 April 1973

PERMANENT ENGINEERING BOARD

General

Article XV of the Columbia River Treaty established a Permanent Engineering Board consisting of two members to be appointed by Canada and two members by the United States. Appointments to the Board were to be made within three months of the date of ratification. The duties and responsibilities of the Board were also stipulated in the Treaty and related documents.



NAVIGATION LOCK entrance at Hugh Keenleyside Dam.

Establishment of the Board

Pursuant to Executive Order No. 11177 dated 16 September 1964 the Secretary of the Army and the Secretary of the Interior on 7 December 1964 appointed two members and two alternate members to form the United States Section of the Permanent Engineering Board. Pursuant to the Department of Energy Organization Act of 4 August 1977 the appointments to the United States Section of the Board are now made by the Secretary of the Army and the Secretary of Energy. The members of the Canadian Section of the Board were appointed by Order in Council P.C. 1964-1671 dated 29 October 1964. Each member was authorized to appoint an alternate member. On 11 December 1964 the two governments announced the composition of the Board.

The names of Board members, alternate members and secretaries are shown in Appendix A. It is noted that on 18 April 1988 Mr. Ronald H. Wilkerson succeeded Mr. J. Emerson Harper as member for the United States and that on 2 November 1987 Mr. T.R. Johnson succeeded Mr. B.E. Marr as member for Canada. On 26 November 1987 Mr. Herbert H. Kennon succeeded Mr. Alex Shwaiko as alternate member for the United States and during the year Mr. H.M. Hunt retired as alternate member for Canada.

Duties and Responsibilities of the Board

The general duties and responsibilities of the Board to the governments, as set forth in the Treaty and related documents, include:

(a) assembling records of the flows of the Columbia River and the Kootenay River at the Canada-United States of America boundary;

(b) reporting to Canada and the United States of America whenever there is substantial deviation from the hydroelectric and flood control operating plans and if appropriate including in the report recommendations for remedial action and compensatory adjustments;

(c) assisting in reconciling differences concerning technical or operational matters that may arise between the entities;

(d) making periodic inspections and requiring reports as necessary from the entities with a view to ensuring that the objectives of the Treaty are being met;

(e) making reports to Canada and the United States of America at least once a year of the results being achieved under the Treaty and making special reports concerning any matter which it considers should be brought to their attention;

(f) investigating and reporting with respect to any other matter coming within the scope of the Treaty at the request of either Canada or the United States of America;

(g) consulting with the entities in the establishment and operation of a hydrometeorological system as required by Annex A of the Treaty.

MICA DAM Columbia River, British Columbia
The earth dam with spillway in operation. The underground powerhouse is at the left.

ENTITIES

General

Article XIV(1) of the Treaty provides that Canada and the United States shall each designate one or more entities to formulate and execute the operating arrangements necessary to implement the Treaty. The powers and duties of the entities are specified in the Treaty and its related documents.

Establishment of the Entities

Executive Order No. 11177, previously referred to, designated the Administrator of the Bonneville Power Administration, Department of the Interior, and the Division Engineer, North Pacific Division, Corps of Engineers, Department of the Army, as the United States Entity with the Administrator to serve as Chairman. Pursuant to the Department of Energy Organization Act of 4 August 1977 the Bonneville Power Administration was transferred to the Department of Energy. Order in Council P.C. 1964-1407 dated 4 September 1964 designated the British Columbia Hydro and Power Authority as the Canadian Entity.

The names of the members of the two entities are shown in Appendix B. It is noted that during this report year Brigadier General Pat M. Stevens, IV replaced Major General Mark J. Sisinyak as a member of the United States Entity.

Power and Duties of the Entities

In addition to the powers and duties specified elsewhere in the Treaty and related documents, Article XIV(2) of the Treaty requires that the entities be responsible for:

(a) coordination of plans and exchange of information relating to facilities to be used in producing and obtaining the benefits contemplated by the Treaty,

(b) calculation of and arrangements for delivery of hydroelectric power to which Canada is entitled for providing flood control,

(c) calculation of the amounts payable to the United States for standby transmission services,

(d) consultation on requests for variations made pursuant to Articles XII(5) and XIII(6),

(e) the establishment and operation of a hydrometeorological system as required by Annex A,

(f) assisting and cooperating with the Permanent Engineering Board in the discharge of its functions,

(g) periodic calculation of accounts,

(h) preparation of the hydroelectric operating plans and the flood control operating plans for the Canadian storage together with determination of the downstream power benefits to which Canada is entitled,

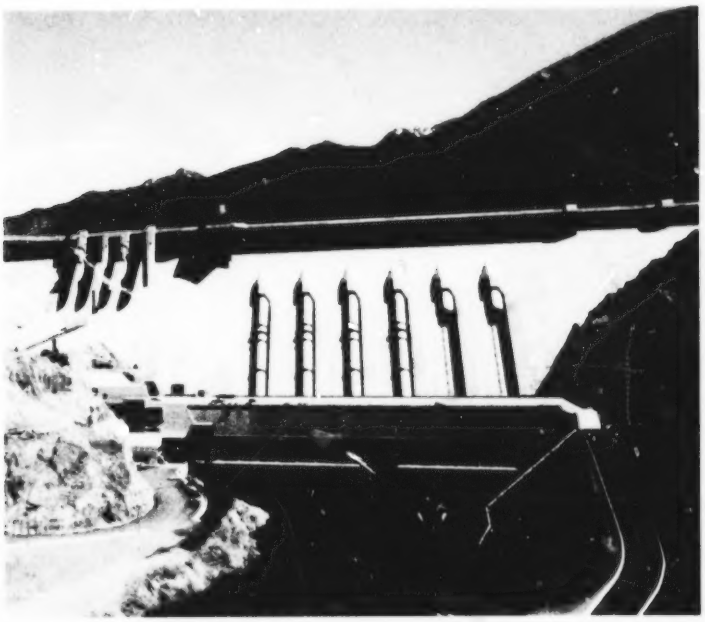
(i) preparation of proposals to implement Article VIII and carrying out any disposal authorized or exchange provided for therein,

(j) making appropriate arrangements for delivery to Canada of the downstream power benefits to which Canada is entitled including such matters as load factors for delivery, times and points of delivery, and calculation of transmission loss,

(k) preparation and implementation of detailed operating plans that may produce results more advantageous to both countries than those that would arise from operation under the plans referred to in Annexes A and B.

Article XIV(4) of the Treaty provides that the two governments may, by an exchange of notes, empower or charge the entities with any other matter coming within the scope of the Treaty.

REVELSTOKE DAM
downstream from Mica Dam.



ACTIVITIES OF THE BOARD

Meetings

The Board met in Portland, Oregon on 5 December 1987 to review progress under the Treaty and to discuss preparation of the Board's Annual Report. The Board met with the Entities on the same day to discuss Entity studies and general progress.

A special briefing was provided by the Entities for the Board on 2 May 1988 in Portland, Oregon. An update on studies of the impact of several proposed changes to the procedures for developing Assured Operating Plans and determining Downstream Power Benefits was provided and progress toward an Entity agreement on these issues was discussed.

Reports Received

Throughout the report year the Canadian Entity provided the Board with weekly reports on operation of the Canadian storage reservoirs and with daily flow forecasts during the freshet season for the northern part of the Columbia River basin. The United States Entity provided monthly reports on the operation of the Libby storage reservoir. The Entities also provided the following documents and reports and made copies of computer printouts of studies for the Assured Operating Plan and downstream power benefit calculations available for review:

— Report of Columbia River Treaty Canadian and United States Entities 1 October 1986 through 30 September 1987, October 1987

— Detailed Operating Plan for Columbia River Treaty Storage 1 August 1987 through 31 July 1988, plus a copy of the Entities' agreement on this document, October 1987

— Issue Papers discussing issues with respect to proposed changes in procedures for determination of Assured Operating Plans and Determination of Downstream Power Benefits

— Summary of results of studies to determine the impact of proposed changes in procedures for determination of Assured Operating Plans and Determination of Downstream Power Benefits

— Entity Agreement on Principles for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefit Studies, July 1988

— Entity Agreement on Changes to Procedures for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefit Studies, August 1988.

Subsequent to the end of this report year, the Board received the following documents and reports from the Entities:

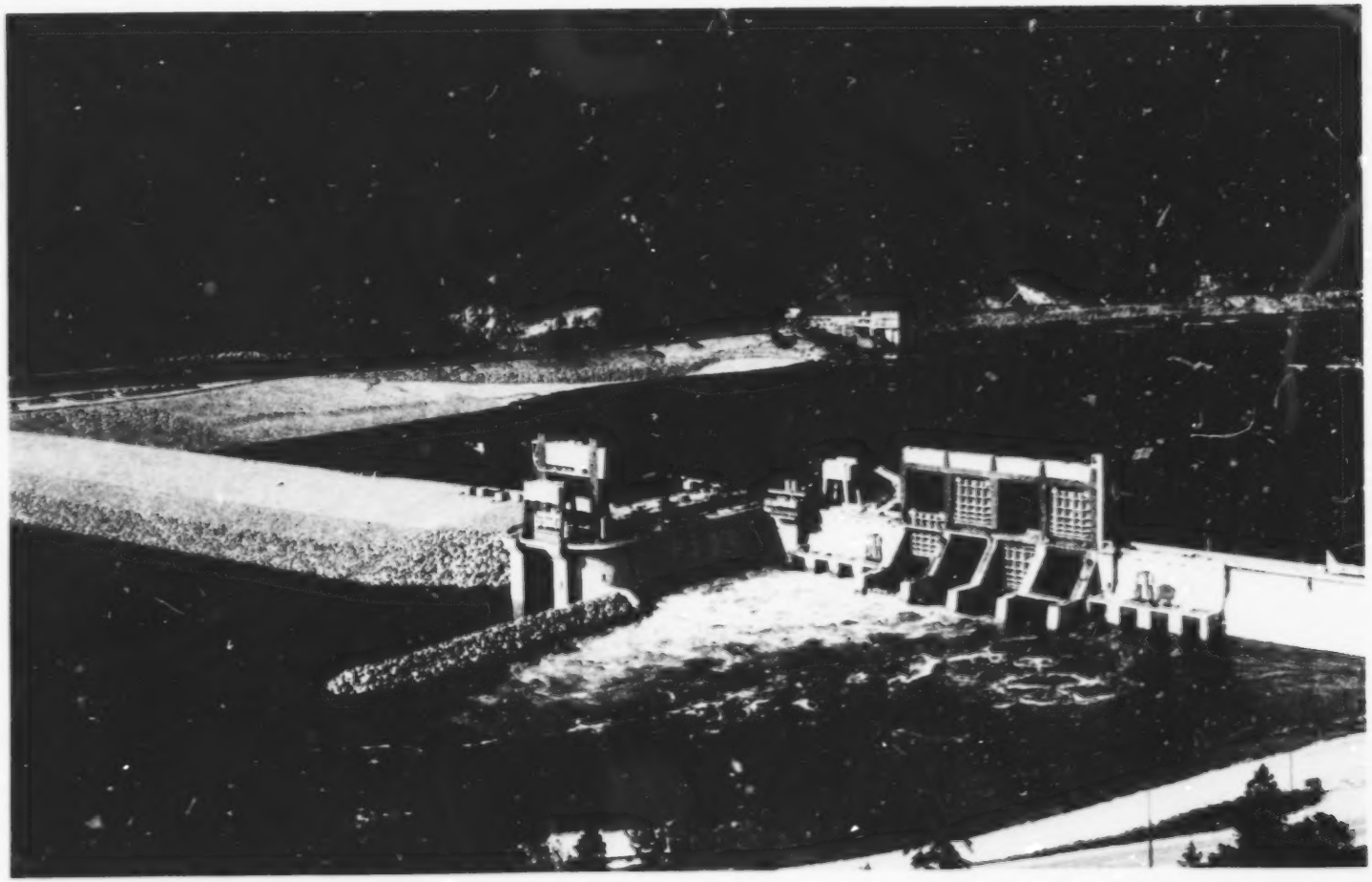
— Assured Operating Plan and Determination of Downstream Power Benefits for Operating Year 1992-93, plus a copy of the Entities' agreement on this document, September 1988

— Annual Report of the Columbia River Treaty, Canadian and United States Entities 1 October 1987 through 30 September 1988

— Detailed Operating Plan for Columbia River Treaty Storage 1 August 1988 through 31 July 1989, plus a copy of the Entities' agreement on this document.

Report to Governments

The twenty-third Annual Report of the Board was submitted to the two governments on 31 December 1987.



HUGH KEENLEYSIDE DAM
Concrete spillway and discharge works with navigation lock and earth dam.

Columbia River, British Columbia

PROGRESS

General

The results achieved under the terms of the Treaty include construction of the Treaty projects, development of the hydrometeorological network, annual preparation of power and flood control operating plans, and the annual calculation of downstream power benefits. The three Treaty storage projects in British Columbia, the Duncan, Arrow and Mica projects, produce power and flood control benefits in both Canada and the United States. The Libby storage project provides power and flood control benefits in both countries. In the United States increased flow regulation provided by Treaty projects has facilitated the installation of additional generating capacity at existing plants on the Columbia River. In Canada completion of the Canal Plant on the Kootenay River in 1976, installation of generators at Mica Dam in 1976-77 and the completion of the Revelstoke project in 1984 have caused power benefits to increase substantially. This amounts to some 4,000 megawatts of generation in Canada that may not have been installed without the Treaty. In addition, the installation of generating capacity at Hugh Keenleyside Dam and at the Murphy Creek Site near Trail, British Columbia is planned for the future.

The Treaty provides Canada with the option of diverting the Kootenay River at Canal Flats into the headwaters of the Columbia River commencing in 1984. British Columbia Hydro and Power Authority has completed engineering feasibility and detailed environmental studies of the potential diversion.

The locations of the above projects are shown on Plate 1 in Appendix D.

Status of the Treaty Projects

Duncan Project

Duncan Dam, the smallest Treaty project, was scheduled by the Sales Agreement for operation by 1 April 1968 and was the first of the Treaty projects to be completed. It became fully operational on 31 July 1967, well in advance of Treaty requirements.

The earthfill dam, about 130 feet high, is located on the Duncan River a few miles north of Kootenay Lake. The reservoir behind the dam extends for about 27 miles and provides 1,400,000 acre-feet of usable storage which is all committed under the Treaty. There are no power facilities included in this project.

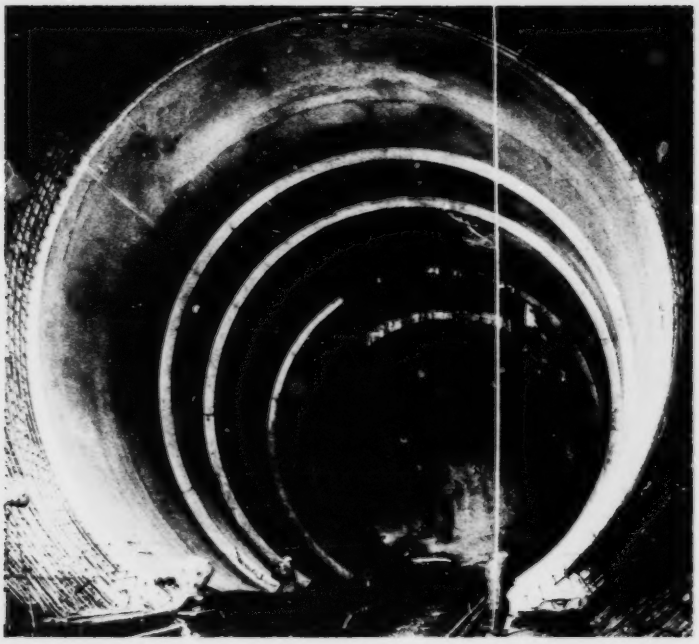
The project is shown in the picture on page 5 and project data are provided in Table 1 of Appendix D.

Arrow Project

The Hugh Keenleyside Dam, at the outlet of the Arrow Lakes, was the second Treaty project to be completed. It became operational on 10 October 1968 well ahead of the date of 1 April 1969 scheduled by the Sales Agreement. The project at present has no associated power facilities, however, installation of generators is planned for the future.

The dam consists of two main components: a concrete gravity structure which includes the spillway, low-level outlets and navigation lock and an earthfill section which rises 170 feet above the riverbed. The reservoir, about 145 miles long, includes both the Upper and Lower Arrow Lakes, and provides 7,100,000 acre-feet of Treaty storage.

The project is shown in the picture on page 16 and project data are provided in Table 2 of Appendix D.



DIVERSION TUNNEL
construction at Mica Dam
during 1967.

Mica Project

Mica Dam, the largest of the Treaty projects, was scheduled by the Sales Agreement for initial operation on 1 April 1973. The project was declared operational and commenced storing on 29 March 1973.

Mica Dam is located on the Columbia River about 85 miles north of Revelstoke, British Columbia. The earthfill dam rises more than 800 feet above its foundation and creates a reservoir 135 miles long, Kinbasket Lake, with a storage capacity of 20,000,000 acre-feet. The project utilizes 12,000,000 acre-feet of live storage of which 7,000,000 acre-feet are committed under the Treaty.

The underground powerhouse has space for a total of six 434 megawatt units with a total capacity of 2,604 megawatts. The first two generators were placed in service late in 1976 and the last of the initial four units commenced operation in October 1977.

The project is shown in the picture on page 10 and project data are provided in Table 3 of Appendix D.

Libby Project in the United States

Libby Dam is located on the Kootenai River 17 miles northeast of the town of Libby, Montana. Construction began in the spring of 1966, storage has been fully operational since 17 April 1973, and commercial generation of power began on 24 August 1975, coincident with formal dedication of the project. The concrete gravity dam rises 370 feet above the riverbed and creates Lake Koocanusa which is 90 miles long and extends 42 miles into Canada. Lake Koocanusa has a gross storage of 5,869,000 acre-feet, of which 4,980,000 acre-feet are usable for flood control and power purposes. The Libby powerhouse, completed in 1976, had four units with a total installed capacity of 420 megawatts.

Construction of four additional units was initiated during fiscal year 1978 and the turbines have been installed. However, Congressional restrictions imposed in the 1982 Appropriations Act provide for completion of only one of these units. That unit became available for service late in 1987. The total installed capacity for the five units is 525 megawatts.

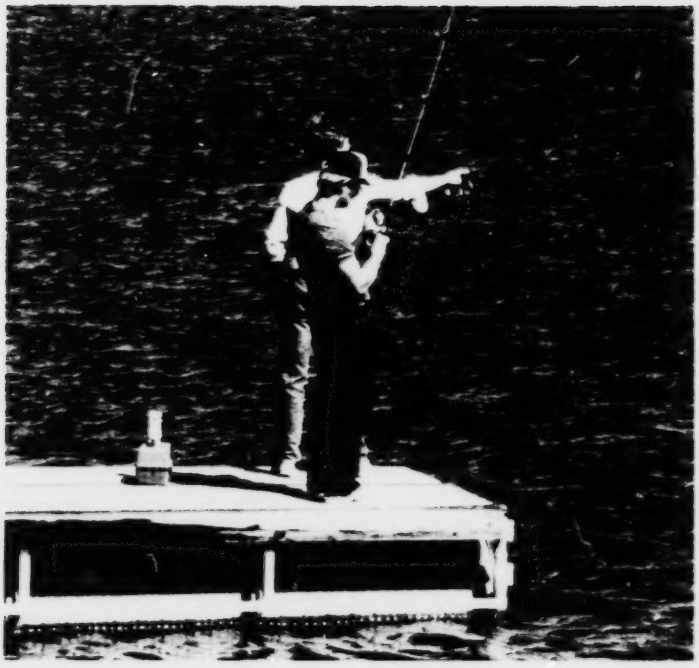
There has been no construction activity on the Reregulating Dam since that project was halted by court order in September 1978.

The Libby project is shown in the picture on page 2 and project data are provided in Table 4 of Appendix D.

Libby Project in Canada

Canada has fulfilled its obligation to prepare the land required for the 42-mile portion of Lake Koocanusa in Canada. British Columbia Hydro and Power Authority has assumed responsibility for reservoir maintenance and debris clean-up.

SPORT FISHING
on Lake Koocanusa.



Hydrometeorological Network

One of the responsibilities assigned to the Entities by the Treaty is the establishment and operation, in consultation with the Permanent Engineering Board, of a hydrometeorological system to obtain data for detailed programming of flood control and power operation. This system includes snow courses, meteorological stations and streamflow gauges. The Columbia River Treaty Hydrometeorological Committee, formed by the Entities, makes recommendations on further development of the Treaty Hydrometeorological System.

In developing the hydrometeorological network, the Entities, with the concurrence of the Board, adopted a document in 1976 which defines the Columbia River Treaty Hydrometeorological System Network and sets forth a method of classifying facilities into those required as part of the Treaty System and those of value as Supporting Facilities. During the 1976-77 report year, the Entities, with the concurrence of the Board, adopted a plan for exchange of operational hydrometeorological data. That plan is still in force.

In the 1985-86 report year the Entities provided the Board with a report "Revised Hydrometeorological Committee Documents" dated November 1985. The report provides up-to-date listings of the hydrometeorological stations and facilities that constitute the network.

Power Operating Plans and Annual Calculation of Downstream Benefits

The Treaty and related documents provide that the Entities are to agree annually on operating plans and on the resulting downstream power benefits for the sixth succeeding year of operation. These operating plans, prepared five years in advance, are called Assured Operating Plans. They represent the basic commitment of the Canadian Entity to operate the Canadian Treaty storage and provide the Entities with a basis for system planning. Canada's commitment to operate under an Assured Operating Plan is tied directly to the benefits produced by that plan. At the beginning of each operating year, a Detailed Operating Plan which includes Libby reservoir is prepared on the basis of current resources and loads to obtain results that may be more advantageous to both countries than those which would be obtained by operating in accordance with the Assured Operating Plan.

The Assured Operating Plan and the Determination of Downstream Power Benefits, for operating year 1992-93, normally completed by the beginning of the report year, was received after the end of the report year. This delay resulted from the fact that the Entities were engaged in studies and negotiations regarding proposed changes to the operating procedures and benefit calculations. The Assured Operating Plan and the Determination of Downstream Power Benefits for operating year 1993-94 is expected to be received by the Board in March 1989.

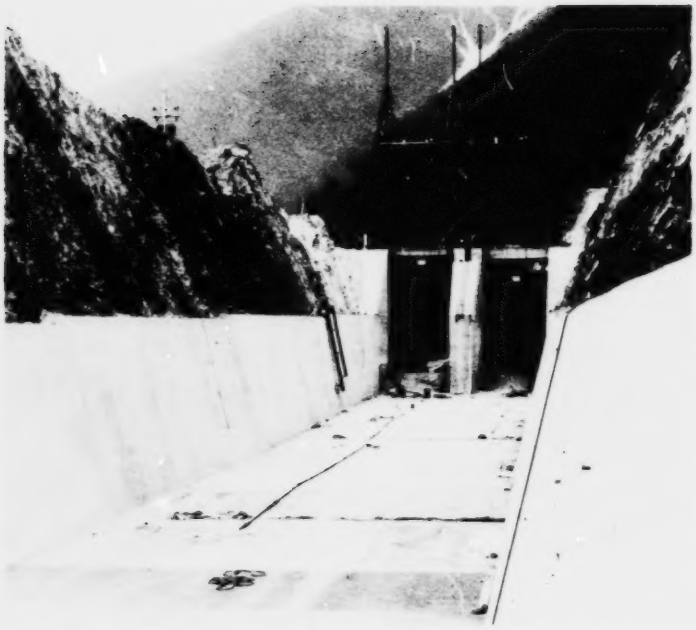
Early in this report year the Entities provided the Board with the Detailed Operating Plan for Canadian Treaty storage and Libby reservoir for the operating year ending 31 July 1988. The Detailed Operating Plan for the operating year ending 31 July 1989 was forwarded to the Board after the end of the report year. These plans contain criteria for operating the Arrow, Duncan, Mica and Libby reservoirs.

In April 1984, the Entities reached an agreement relating to the initial filling of non-Treaty reservoirs, the use of non-Treaty storage, and Mica and Arrow reservoir refill enhancement. This agreement remained in effect throughout the report year. Operations under the agreement did not interfere with Treaty operations and were consistent with Treaty objectives.

The Northwest Power Planning Council was established by Act of Congress in 1980 to prepare a program for improvement of fish and wildlife in the Columbia River Basin and to develop a conservation and electric power plan for the Pacific Northwest. The Council, on 15 November 1982, adopted the Columbia River Basin Fish and Wildlife Program which establishes a water budget. This budget reserves 3.45 million acre-feet of storage upstream from Priest Rapids Dam on the Columbia River and 1.19 million acre-feet upstream from Lower Granite Dam on the Snake River. This storage is used by United States' project operators when it is required to improve low flows in the main rivers during the downstream migration of anadromous fish. Fisheries and native Indian interests control use of the storage for this purpose. The use of Canadian Treaty storage is advocated by the United States Northwest Power Planning Council in its Fish and Wildlife Program.

With regard to the use of Canadian Treaty storage to meet water budget purposes, the Board has stated in previous reports that the assured operating plans are to provide for optimum operation for power and flood control. The Board has also noted, however, that the Entities may agree to provide water for fish migration under detailed operating arrangements providing this does not conflict with Treaty requirements.

SPILLWAY AT DUNCAN DAM completed in 1967.



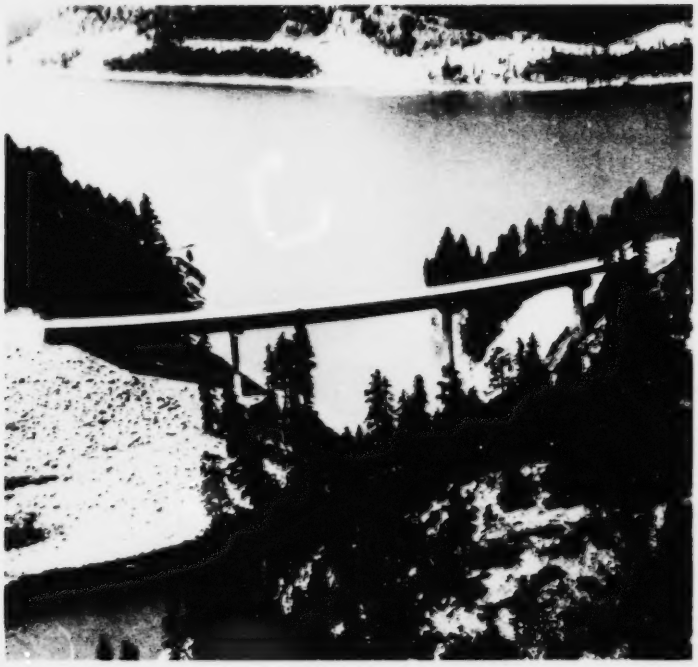
During this report year the Entities completed their studies of the impact of several proposed changes to Treaty reservoir operating procedures and to the determination of downstream power benefits. These studies were reported by the Entities as being the most thorough and complex examination of the technical aspects of the Columbia River Treaty since the ratification in 1964. Near the end of the report year, the Entities signed two agreements relating to changes in the principles and procedures used in preparing the assured operating plans and in calculating downstream power benefits. Specific changes resulting from the two Entity agreements include the use of updated streamflows in all steps of the calculations, updated estimates of irrigation withdrawals and return flows, a revised definition of power loads and generating resources, the use of updated power system operating technology, and consistent application of operating procedures through all steps of the calculations.

The Board notes that the changes provided for in the two Entity agreements resolve the concerns which the Board has expressed in recent annual reports.

Flood Control Operating Plans

The Treaty provides that Canadian storage reservoirs will be operated by the Canadian Entity in accordance with operating plans designed to minimize flood damage in the United States and Canada.

The Columbia River Treaty Flood Control Operating Plan defines flood control operation of the Duncan, Arrow, Mica and Libby reservoirs. This plan was received from the Entities and reviewed by the Board in the 1972-73 report year and is still in effect.



RELOCATED HIGHWAY
along Lake Koocanusa.

Flow Records

Article XV(2)(a) of the Treaty specifies that the Permanent Engineering Board shall assemble records of flows of the Columbia and Kootenay Rivers at the Canada-United States of America boundary. Flows for this report year are tabulated in Appendix C for the Kootenai River at Porthill, Idaho and for the Columbia River at Birchbank, British Columbia.

OPERATION

General

The Columbia River Treaty Operating Committee was established by the Entities to develop operating plans for the Treaty storages and to direct operation of these storages in accordance with the terms of the Entity agreements.

During the report year the Treaty storage in Canada was operated by the Canadian Entity in accordance with:

— Columbia River Treaty Flood Control Operating Plan

— Detailed Operating Plan for Columbia River Treaty Storage 1 August 1987 through 31 July 1988

— Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1987-88

— Columbia River Treaty Hydroelectric Operating Plan, Assured Operating Plan for Operating Year 1988-89.

In addition, the following agreements were in effect during this period:

— An agreement between the Entities dated 9 April 1984 relating to:

  — Agreement between British Columbia Hydro and Power Authority and Bonneville Power Administration Relating to: (1) Initial Filling of Non-Treaty Reservoirs, (2) The Use of Columbia River Non-Treaty Storage and (3) Mica and Arrow Reservoir Refill Enhancement

— Contract between Bonneville Power Administration and Mid-Columbia Purchasers Relating to Federal and Canadian Columbia River Storage

— Columbia River Treaty Entity Agreement on Principles for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefits, July 1988

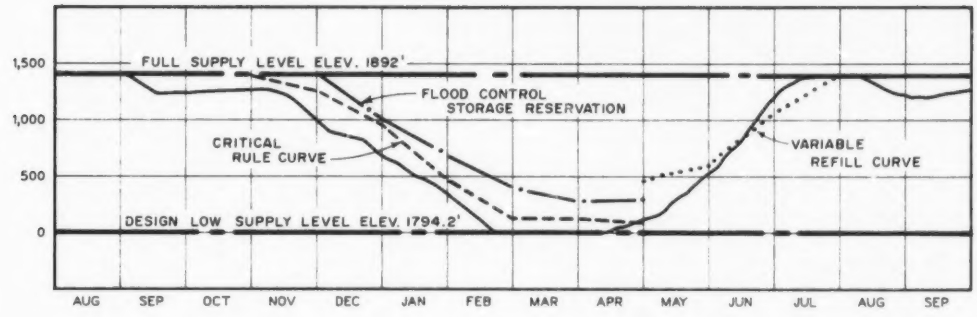
— Columbia River Treaty Entity Agreement on Changes to Procedures for the Preparation of the Assured Operating Plan and Determination of Downstream Power Benefit Studies, August 1988.

Power Operation

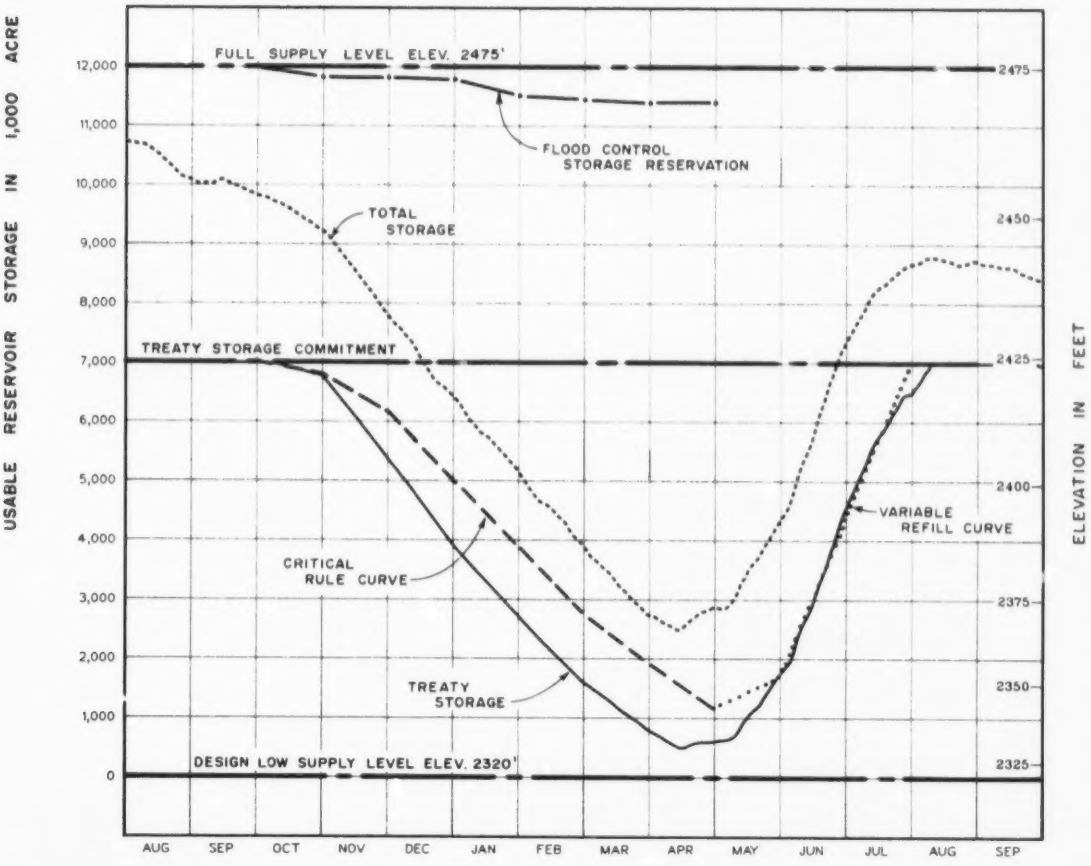
The three Canadian Treaty reservoirs, Duncan, Arrow and Mica, and the Libby reservoir in the United States were in full operation throughout this report year.

The total Treaty storage volume filled during the summer of 1987. However, all reservoirs did not reach their full supply levels because non-Treaty storage space did not fill in the Mica reservoir and there was a transfer of Treaty storage water from the Arrow to the Revelstoke reservoir. At the start of the report year drafting had begun at Libby, Duncan and Arrow projects while drafting at Mica began shortly thereafter. Low inflows occurred throughout most of the year resulting in below normal reservoir levels and requiring proportional drafting rules.

This report year was the second consecutive year of significantly below normal streamflow conditions in the basin. Higher flows that occurred in the March through May period were due partly to increased precipitation and partly to an earlier than usual snowmelt period. In spite of a low volume of inflow during the freshet period most Treaty storage refilled during the summer of 1988. The exception was the Arrow reservoir which reached 86.6 percent of its Treaty storage capacity. By the end of September 1988, drafting had begun at all projects.

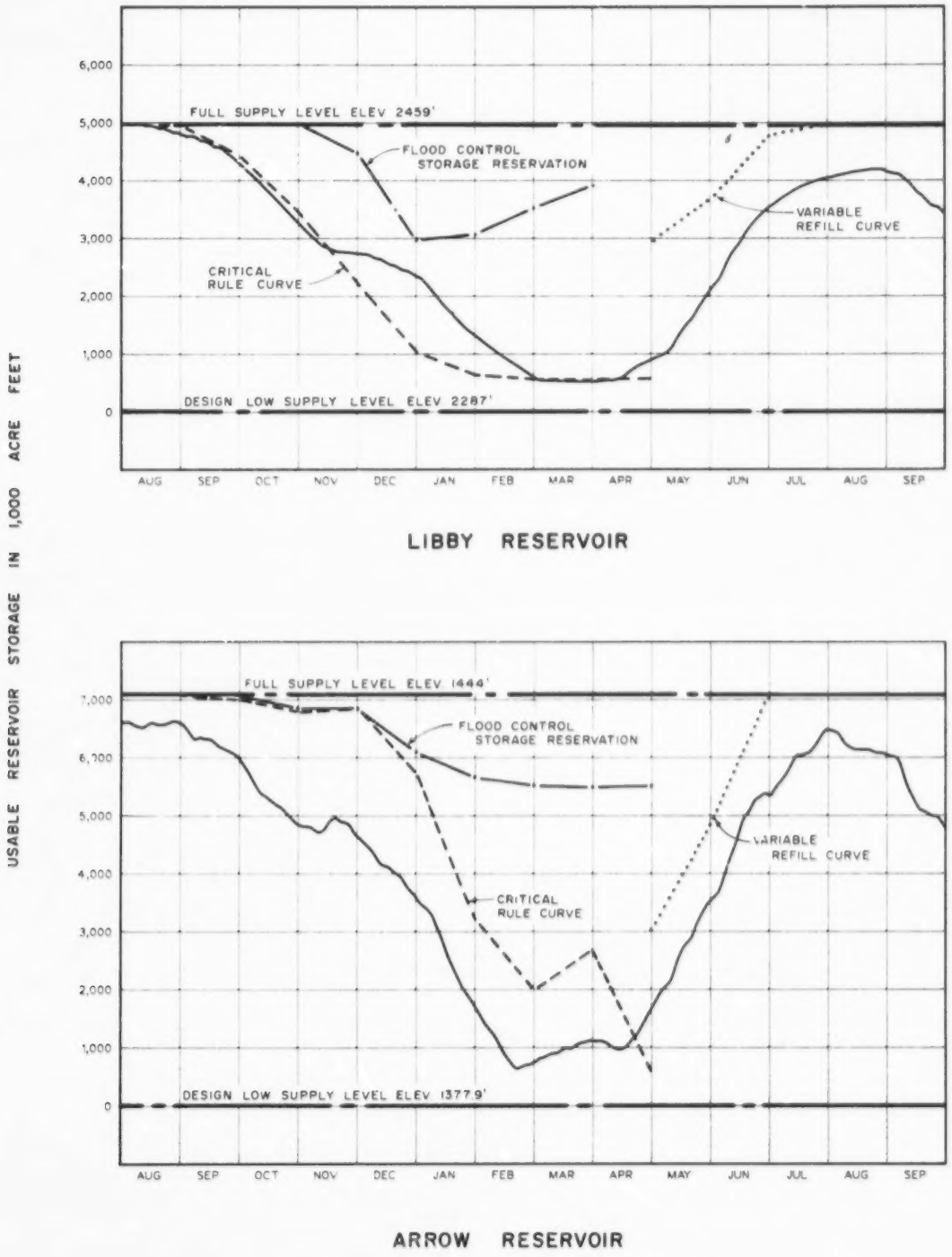


DUNCAN RESERVOIR



MICA RESERVOIR

HYDROGRAPHS — Duncan and Mica reservoir levels for the 14-month period ending 30 September 1988.



HYDROGRAPHS — Libby and Arrow reservoir levels for the 14-month period ending 30 September 1988.

During the year some storage was transferred between Mica, Revelstoke and Arrow storage accounts as permitted under the Entities' Storage Agreement of April 1984. These storage transfers were accomplished without disrupting Treaty operations.

Commencing in the 1984 report year, operation in the United States incorporated requirements of the Northwest Power Planning Council's Fish and Wildlife Program. This program specifies a water budget for use during the period 15 April to 15 June to meet minimum flow requirements for the downstream migration of anadromous fish. In this report year the water budget of 3.45 million acre-feet for Priest Rapids on the Columbia River was utilized between 9 May and 10 June.

Operation of the reservoirs is illustrated on pages 28 and 29 by hydrographs which show actual reservoir levels and some of the more important rule curves which govern operation of the Treaty storages. The Flood Control Storage Reservation curve specifies maximum month-end reservoir levels which will permit evacuation of the reservoir to control the forecast freshet. The Critical Rule Curve shows minimum month-end reservoir levels which should be maintained to enable the anticipated power demands to be met under adverse water supply conditions. The Variable Refill Curve shows reservoir elevations necessary to ensure refilling the reservoir by the end of July with a reasonable degree of confidence. Similar rule curves which apply to operation of the combined Canadian Treaty storages have also been provided to the Board.

Since Mica reservoir contains both Treaty and non-Treaty storage, a separate hydrograph is shown for Treaty storage in terms of acre-feet of storage volume, along with relevant rule curves. Also shown is a hydrograph of total reservoir storage in terms of both storage volumes and reservoir elevations.

At the start of the report year Duncan reservoir had begun drafting and was at elevation 1882.8 feet, approximately nine feet below full pool. Throughout October and early November, releases were curtailed to minimize spill at Kootenay River power projects. Drafting resumed on 8 November and continued until the end of February when a minimum reservoir elevation of 1794.2 feet was reached. The reservoir was

held at this elevation until mid-April. Discharge was reduced to the specified minimum of 100 cfs and the reservoir filled rapidly. On 4 July 1988 discharge was increased to reduce the rate of filling. Duncan reservoir reached its full pool elevation of 1892 feet on 26 July. Storage drafting began on 10 August, then was curtailed from September 11 to the end of the report year. At the end of September the reservoir elevation was 1884.5 feet.

Arrow reservoir was at elevation 1435.4 feet, 8.6 feet below its full level, on 1 October 1987. Drafting, which had begun in September, continued until 11 November when outflows were reduced to retain non-Treaty storage. By 20 November, when drafting resumed, the reservoir had filled by three feet. Drafting continued heavily throughout the winter, and levels fell well below target levels under proportional drafting rules. On 21 February the year's lowest level was reached at 1385.5 feet.

CONSTRUCTION at Arrow Project during 1968.

The reservoir filled slowly through March and April, then during the period 24 April to 8 May discharge was reduced to 10,000 cfs, accelerating the filling. Refill continued steadily throughout June and July and on 31 July the reservoir level peaked at 1439.2 feet. This represented 86.6 percent of the Treaty storage volume available at the Arrow project and an additional 2.7 feet of non-Treaty water.

Heavy drafting of Treaty storage began in August, however, non-Treaty water was transferred from Mica reservoir to maintain recreation levels until early September. Beginning 6 September rapid drawdown resumed as non-Treaty storage was transferred back to Mica reservoir. Arrow reservoir reached 1425.5 feet by the end of September.

Mica reservoir began the report year at elevation 2454 feet, twenty-one feet below full pool level. The Treaty storage was full but drafting of non-Treaty storage had begun. On October 5, drafting of Treaty storage commenced. Heavy drafting continued through the fall and winter period, bringing the reservoir well below its operating rule curve. The lowest level for the year, 2365.2 feet, was reached on 15 April. This was the lowest reservoir level reached since initial filling in 1976.

Inflows into the reservoir were near average during May and June and during this period the reservoir filled rapidly. By 30 June levels had returned to target elevations and, by 10 August, Treaty storage space had refilled. Non-Treaty storage was not refilled and the reservoir level reached 2443.2 feet, thirty-two feet below full pool. During September non-Treaty storage was drafted and by 30 September the reservoir was at elevation 2439.2 feet.

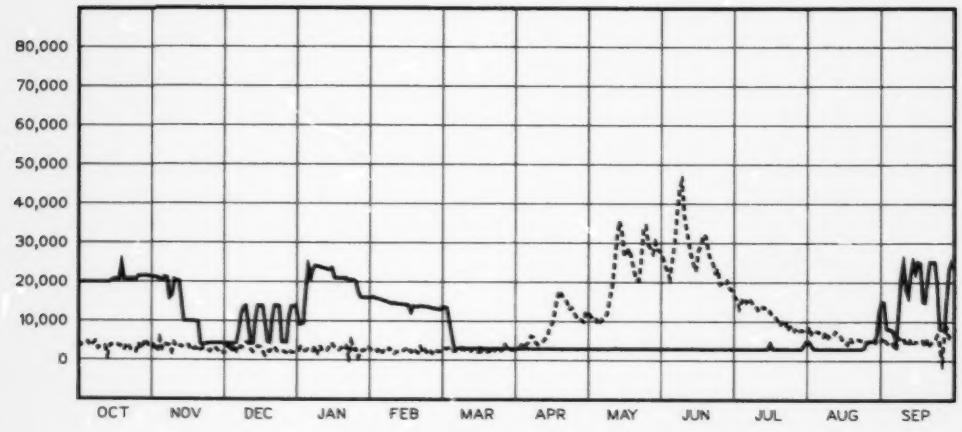
On 1 October 1987, Libby reservoir had begun drafting and was at elevation 2444.5 feet, 14.5 feet below full pool level. Drafting continued through the fall with conservation measures in effect because of the low water supply. In January it was necessary to increase outflows to full powerhouse capacity to meet firm loads. Drafting continued until 26 March when the reservoir reached its lowest level of 2317.4 feet.

Reservoir inflows were heaviest in the mid-April to late-June period. Refill continued through the summer until a peak elevation of 2441.5 feet, 17.5 feet below full pool, was reached on 24 August. Drafting of the reservoir began immediately and by 30 September the reservoir was down to 2422.7 feet.

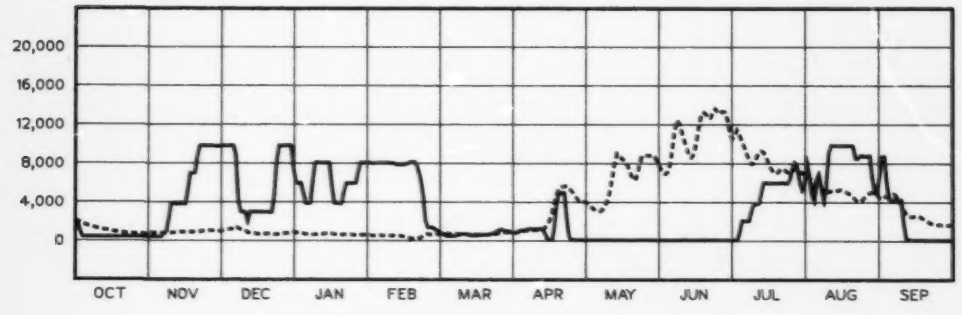
Flood Control Operation

Flood control operation was not necessary in this report year due to very dry conditions in the Columbia River basin and below normal streamflows. Although daily flood control operations were not needed, the reservoirs were operated to provide flood control storage space as required by the Treaty.

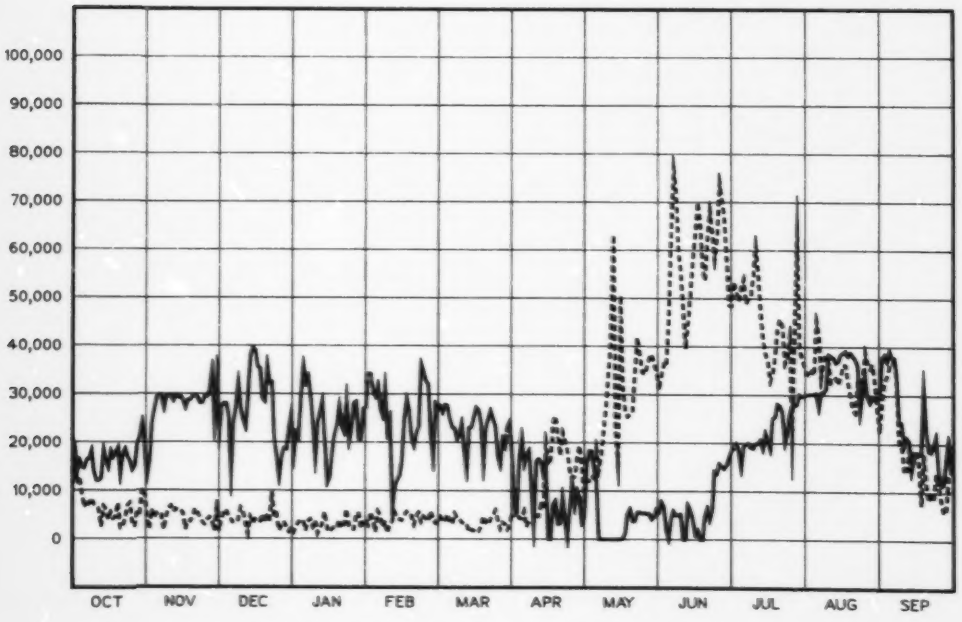
DISCHARGE IN CUBIC FEET PER SECOND



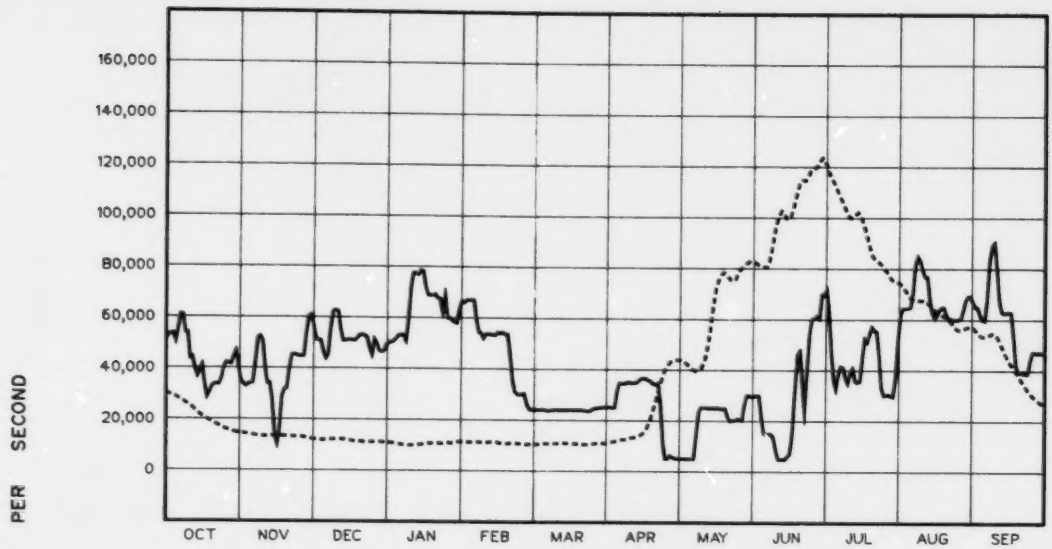
KOOTENAI RIVER AT LIBBY DAM



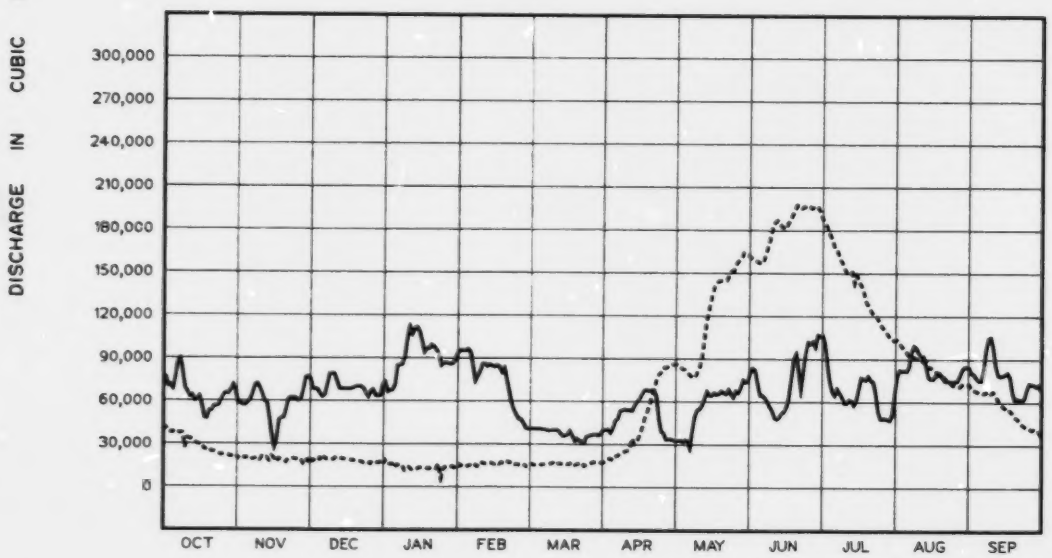
DUNCAN RIVER AT DUNCAN DAM



COLUMBIA RIVER AT MICA DAM



COLUMBIA RIVER AT HUGH KEENLEYSIDE DAM



COLUMBIA RIVER AT BIRCHBANK

LEGEND

Observed Flows

Pre-Project Flows

HYDROGRAPHS — Observed and pre-project flows for year ending 30 September 1988.

BENEFITS

Flood Control Provided

There were no significant flood control benefits this year. Without regulation the 1988 freshet would have resulted in below average peak discharges at Trail, British Columbia and at The Dalles, Oregon and would not have caused flooding.

It is estimated that the Duncan and Libby projects reduced the peak stage on Kootenay Lake by about four and one half feet and that the Duncan, Arrow, Mica and Libby projects reduced the peak stage of the Columbia River at Trail, British Columbia by about nine feet. The effect of storage in the Duncan, Arrow, Mica and Libby reservoirs on flows at the sites and on flows of the Columbia River at Birchbank is illustrated on page 34 by hydrographs which show both the actual discharges and the flows that would have occurred if the dams had not been built. It is noted that the hydrograph showing pre-project conditions for Birchbank has been computed on the assumption that the effects of Duncan, Arrow, Mica and Libby regulation and of the regulation provided by the Corra Linn development on Kootenay Lake have been removed.

The operation of Columbia Basin reservoirs for the system as a whole reduced the natural annual peak discharge of the Columbia River near The Dalles, Oregon from about 392,000 cfs to 236,000 cfs.

All payments required by Article VI(1) as compensation for flood control provided by the Canadian Treaty storage projects have been made by the United States to Canada; the final payment was made on 29 March 1973 when the Mica project was declared operational.

Power Benefits

Downstream power benefits in the United States which arise from operation of the Canadian Treaty storage were pre-determined for the first thirty years of operation of

VISITOR'S CENTRE at Libby Dam.

each project and the Canadian one-half share was sold in the United States under the terms of the Canadian Entitlement Purchase Agreement. The United States Entity delivers capacity and energy to Columbia Storage Power Exchange participants as purchasers of the Canadian Entitlement. The benefits of additional generation made possible on the Kootenay River in Canada as a result of regulation provided by Libby, and generation at the Mica and Revelstoke projects, are retained wholly within Canada. The benefits from Libby regulation which occur downstream in the United States are not shareable under the Treaty.

Other Benefits

By agreement between the Entities, as in previous report years, streamflows were regulated for non-power purposes such as accommodating construction in river channels and providing water to assist the downstream migration of juvenile fish in the United States. These arrangements were implemented under the Detailed Operating Plan and provided mutual benefits to the Entities.

CONCLUSIONS

1. The Duncan, Arrow, Mica and Libby projects have been operated in conformity with the provisions of the Treaty. Operation reflected detailed operating plans developed by the Entities, the flood control operating plan for Treaty reservoirs, and an agreement between the Entities relating to the use of non-Treaty storage and refill enhancement of Mica and Arrow reservoirs. Operation under this agreement did not conflict with normal Treaty operations.

2. The Entities have reached agreement on the detailed operating plan for Columbia River Treaty Storage for 1988-89.

3. Entity evaluations pertaining to development of the hydrometeorological network, power operating plans, and the calculation of downstream power benefits are proceeding. The Assured Operating Plan and the Determination of Downstream Power Benefits for operating years 1992-93, delayed pending completion of the two Entity agreements in 1988, have been received. The corresponding documents for 1993-94 are expected in March 1989. No further delays are anticipated.

4. The two Entity agreements signed in 1988 resolve concerns which the Board has expressed in recent annual reports. They clarify operating procedures and how downstream power benefits will be calculated, resolve issues which have been under discussion for several years, and will facilitate meeting Treaty objectives.

5. The objectives of the Treaty are being met.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

United States	Canada
Members	
Mr. Lloyd A. Duscha, Chairman Deputy Director, Engineering & Construction Directorate, H.Q., U.S. Army Corps of Engineers, Washington, D.C.	Mr. G.M. MacNabb, Chairman R.R. #2, North Gower, Ontario
Mr. Ronald H. Wilkerson 1) 4655 Highway 200 East, Missoula, Montana	Mr. T.R. Johnson 2) 1276 Queensbury Ave., Victoria, B.C.
Alternates	
Mr. Herbert H. Kennon 3) Chief, Engineering Division, H.Q., U.S. Army Corps of Engineers, Washington, D.C.	Mr. E.M. Clark Director, Pacific and Yukon Region, Inland Waters, Department of the Environment, Vancouver, B.C.
Mr. Thomas L. Weaver Assistant Administrator for Engineering, Western Area Power Administration, Department of Energy, Golden, Colorado	Vacant 4)
Secretaries	
Mr. S.A. Zanganeh Hydraulics & Hydrology Division, Engineering & Construction Directorate, H.Q., U.S. Army Corps of Engineers, Washington, D.C.	Mr. E.M. Clark Director, Pacific and Yukon Region, Inland Waters, Department of the Environment, Vancouver, B.C.

1) Vice Mr. J. Emerson Harper as of 18 April 1988
2) Vice Mr. B.E. Marr as of 2 November 1987
3) Vice Mr. Alex Shwaiko as of 26 November 1987
4) Mr. H.M. Hunt retired in March 1988.

APPENDIX A

COLUMBIA RIVER TREATY PERMANENT ENGINEERING BOARD

Record of Membership

Members

United States		Canada	
Mr. Wendell E. Johnson 1)	1964-1970	Mr. G.M. MacNabb 1)	1964-
Mr. Morgan E. Dubrow	1964-1970	Mr. A.F. Paget	1964-1973
Mr. John W. Neuberger	1970-1973	Mr. V. Raudsepp	1973-1974
Mr. Joseph B. Caldwell 1)	1971-1973	Mr. B.E. Marr	1974-1987
Mr. Homer B. Willis 1)	1973-1979	Mr. T.R. Johnson	1987-
Mr. C. King Mallory	1973-1975		
Mr. Raymond A. Peck, Jr.	1976-1977		
Mr. J. Emerson Harper	1978-1988		
Mr. Lloyd A. Duscha 1)	1979-		
Mr. Ronald H. Wilkerson	1988-		

Alternates

Mr. Fred L. Thrall	1964-1974	Mr. E.M. Clark	1964-
Mr. J. Emerson Harper	1964-1978	Mr. J.T. Rothwell	1964-1965
Mr. Alex Shwaiko	1974-1987	Mr. H.M. Hunt	1966-1988
Mr. Thomas L. Weaver	1979-		
Mr. Herbert H. Kennon	1987-		

Secretaries

Mr. John W. Roche	1965-1969	Mr. E.M. Clark	1964-
Mr. Verle Farrow	1969-1972		
Mr. Walter W. Duncan	1972-1978		
Mr. S.A. Zanganeh	1978-		

1) Chairman

APPENDIX B

COLUMBIA RIVER TREATY ENTITIES

United States

Mr. James J. Jura, Chairman

Administrator, Bonneville
Power Administration,
Department of Energy,
Portland, Oregon

Brigadier General Pat M. Stevens, IV

Division Engineer,
U.S. Army Engineer Division, North Pacific,
Portland, Oregon

Canada

Mr. L.I. Bell, Chairman

Chairman, British Columbia
Hydro and Power Authority,
Vancouver, B.C.

APPENDIX C

RECORD OF FLOWS

AT THE

INTERNATIONAL BOUNDARY

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	20,100	21,600	5,370	12,400	16,900	14,400	5,390	12,500	10,600	5,590	5,370	13,800
2	20,200	21,700	5,490	9,490	16,400	14,400	5,560	11,300	10,900	5,440	5,720	13,000
3	20,100	21,800	5,680	9,520	16,400	14,400	8,160	10,500	10,700	5,570	4,770	8,400
4	20,100	21,600	5,960	9,870	16,100	14,100	9,940	9,880	10,400	5,460	4,120	7,990
5	20,200	21,500	6,200	18,400	16,100	11,200	8,900	9,730	10,300	5,290	3,980	7,880
6	20,200	21,500	6,360	20,800	15,900	8,130	8,640	9,730	10,500	5,200	3,990	6,820
7	20,500	21,400	7,020	23,300	15,600	5,740	17,300	10,100	10,500	5,250	4,060	5,940
8	20,600	21,200	9,830	23,800	15,400	5,240	18,200	10,800	9,960	4,960	4,010	12,600
9	20,600	14,300	13,600	24,200	15,500	5,040	14,400	12,000	9,820	4,870	4,070	21,700
10	20,600	18,700	15,200	24,400	15,600	5,270	11,700	13,000	9,450	4,820	4,050	21,600
11	20,700	20,600	14,400	24,500	15,500	5,280	10,500	14,600	9,360	4,620	4,250	17,600
12	20,800	20,800	10,200	24,400	15,500	4,920	10,600	17,000	8,960	4,640	4,280	17,800
13	20,700	21,000	6,630	24,200	15,600	4,770	12,200	19,400	8,550	4,490	4,000	23,200
14	20,900	14,700	6,250	24,400	15,800	4,770	14,700	18,800	8,360	4,480	3,910	23,000
15	21,100	11,100	12,400	24,400	15,700	4,910	17,400	16,600	8,100	4,550	3,910	24,000
16	21,100	10,700	14,000	23,300	15,700	4,570	20,700	15,300	7,830	4,720	3,960	24,600
17	21,000	10,600	14,000	22,400	14,900	4,450	24,000	15,800	7,810	5,760	4,250	21,900
18	21,000	10,500	13,300	22,100	14,600	4,630	25,300	14,800	7,630	4,830	4,010	16,000
19	21,100	10,400	13,800	22,000	15,300	4,420	23,400	13,400	7,330	4,460	3,970	15,600
20	21,300	10,400	6,120	21,900	15,400	4,300	20,600	12,500	6,910	4,260	4,540	22,300
21	21,100	9,560	6,080	22,000	15,000	4,200	18,700	12,300	6,790	4,180	4,090	24,800
22	21,400	5,560	12,300	21,900	15,000	4,440	17,100	12,700	6,750	4,160	4,140	25,300
23	21,600	5,270	13,800	21,500	14,900	4,330	15,500	13,800	6,340	4,590	4,060	24,100
24	21,600	5,380	13,800	21,500	14,700	4,480	14,500	14,100	6,180	4,210	4,130	17,500
25	21,600	5,530	12,000	21,300	14,700	4,540	13,300	13,000	6,070	4,180	4,400	9,810
26	21,700	5,410	6,280	20,600	14,700	4,660	12,100	12,500	6,110	4,160	5,250	9,060
27	21,800	5,550	5,850	17,700	14,500	5,820	11,100	12,200	5,980	4,040	5,340	9,320
28	21,700	5,540	5,900	16,900	14,500	7,280	10,800	12,500	6,070	3,940	5,360	18,600
29	21,500	5,410	11,800	16,900	14,500	6,620	12,400	12,300	5,880	4,000	5,370	24,300
30	21,600	5,390	13,100	16,800		6,060	13,300	11,900	5,810	4,060	7,090	25,200
31	21,700		13,200	17,100		5,560		11,000		4,790	12,200	
Mean	21,000	13,500	9,870	20,100	15,400	6,550	14,200	13,100	8,200	4,700	4,730	17,100

KOOTENAI RIVER AT PORTHILL, IDAHO — Daily discharges for the year ending 30 September 1988 in cubic feet per second.

Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	74,900	58,300	75,900	73,500	95,500	41,000	40,400	32,900	81,000	107,000	78,200	80,500
2	76,300	58,600	68,500	66,400	95,500	41,000	40,400	32,800	83,800	101,000	82,500	79,900
3	70,300	57,200	68,500	67,400	95,300	40,800	40,500	33,000	82,400	86,600	81,900	77,100
4	71,000	57,200	68,200	67,900	96,300	40,800	38,000	32,200	72,800	73,700	82,300	75,300
5	68,500	59,000	65,000	71,100	94,400	40,900	41,400	33,200	64,700	67,000	82,000	75,200
6	76,600	60,700	62,900	84,600	84,800	40,700	46,800	32,600	64,800	64,800	84,900	83,100
7	87,600	65,000	64,300	85,600	74,000	40,400	48,000	27,500	63,400	69,400	95,600	97,500
8	89,700	71,300	71,700	85,600	77,300	40,400	53,800	40,400	60,400	66,900	99,500	105,000
9	81,200	72 [illegible]0	79,100	90,700	80,800	39,500	53,900	50,300	56,400	64,000	98,100	106,000
10	68,900	69,600	79,500	105,000	86,300	39,900	54,600	54,400	54,300	59,500	94,700	97,800
11	66,400	65,000	79,100	112,000	86,100	40,000	54,100	55,000	48,900	59,500	92,100	85,000
12	62,900	59,700	74,200	107,000	84,600	39,900	54,500	57,500	48,200	61,900	92,000	79,300
13	63,900	59,300	68,500	111,000	85,900	39,900	53,800	62,400	49,600	61,100	85,300	78,500
14	60,000	49,100	68,500	112,000	84,900	37,800	57,600	67,600	52,300	57,900	77,800	78,700
15	60,700	36,000	68,500	109,000	84,000	35,700	59,900	64,800	53,500	61,300	76,400	79,600
16	63,200	27,200	68,500	101,000	85,000	36,000	62,200	64,600	56,600	69,100	76,200	81,000
17	57,200	32,800	68,500	93,800	84,100	36,700	65,000	66,400	62,700	77,300	78,900	78,200
18	48,000	46,600	68,500	96,700	80,000	39,600	68,100	65,400	75,800	76,600	79,000	66,800
19	47,700	48,400	69,200	96,900	83,300	36,000	68,500	65,700	90,200	75,600	80,200	61,400
20	53,300	48,400	70,300	99,300	74,900	32,400	67,900	67,900	94,000	78,400	77,400	62,700
21	53,300	54,400	70,300	98,300	66,300	34,100	68,100	66,500	82,400	75,500	74,900	61,900
22	56,500	61,800	70,300	95,800	58,200	32,400	68,600	65,800	68,400	74,600	75,000	62,000
23	56,500	62,500	68,900	92,700	53,500	32,200	63,600	68,800	81,400	66,800	74,700	62,800
24	57,200	62,500	65,000	84,700	50,300	31,100	48,200	65,500	95,100	53,500	74,500	69,300
25	61,100	62,200	62,900	86,700	47,200	35,800	39,300	63,200	102,000	48,200	74,600	73,500
26	64,300	60,000	66,700	86,900	47,500	36,100	38,200	67,800	101,000	48,400	75,000	72,600
27	65,700	61,100	68,200	86,700	44,500	36,600	33,500	66,200	103,000	48,700	78,000	72,700
28	65,300	67,500	63,900	86,000	41,000	36,600	33,800	69,800	98,600	48,000	82,500	71,200
29	67,800	76,600	63,600	86,500	41,100	36,900	33,800	75,400	107,000	47,400	84,800	72,500
30	71,300	77,300	63,900	90,100		36,300	33,200	73,700	106,000	51,700	85,200	68,600
31	67,100		72,000	94,400		37,900		74,800		66,400	84,400	
Mean	65,600	58,300	69,100	91,100	74,600	37,600	51,000	56,900	75,400	66,700	82,500	77,200

COLUMBIA RIVER AT BIRCHBANK, B.C. — Daily discharges for the year ending 30 September 1988 in cubic feet per second.

APPENDIX D

PROJECT INFORMATION

Power and Storage Projects,
Northern Columbia Basin — Plate No. 1

Project Data
Duncan Project — Table No. 1
Arrow Project — Table No. 2
Mica Project — Table No. 3
Libby Project — Table No. 4

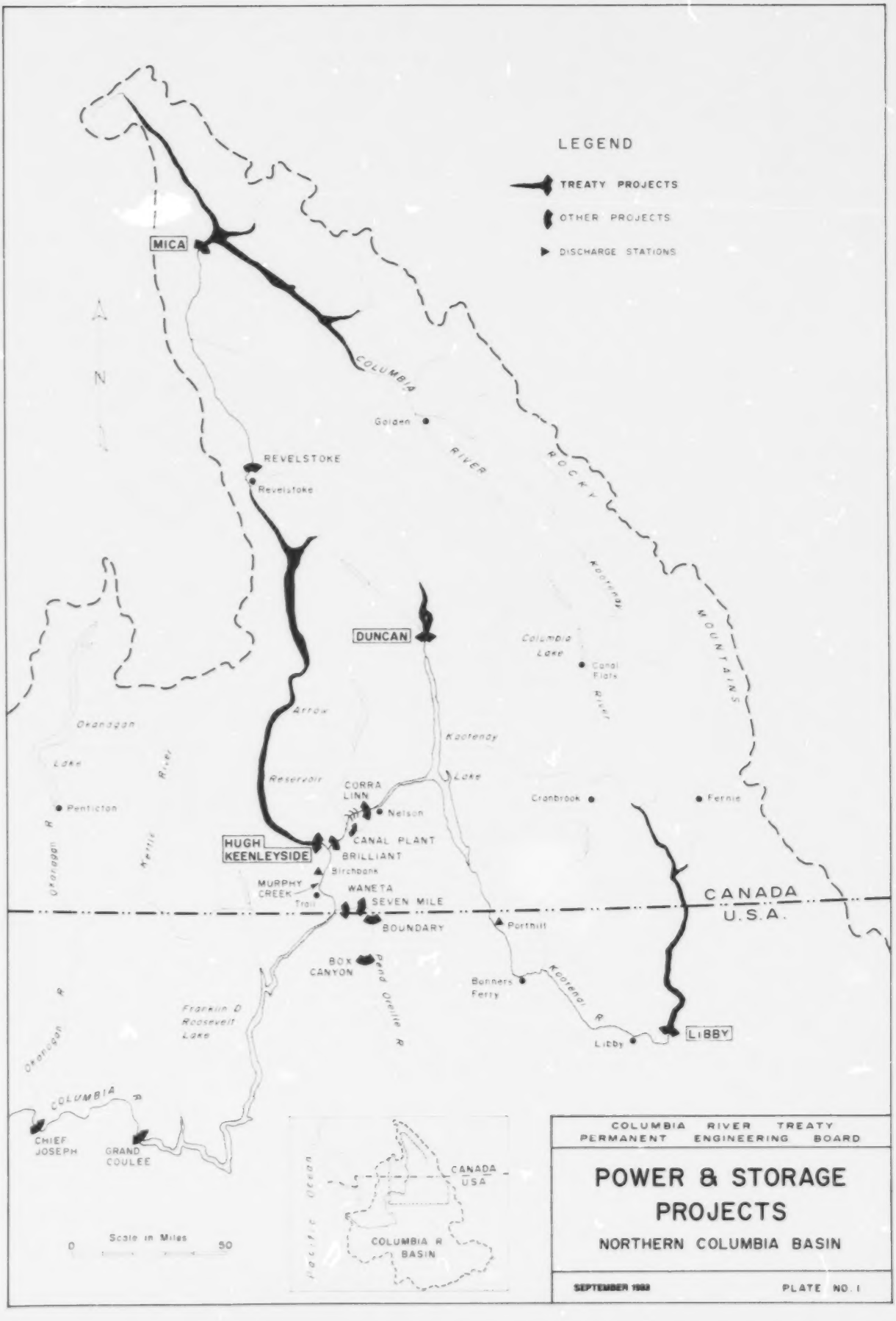

LEGEND
TREATY PROJECTS
OTHER PROJECTS
DISCHARGE STATIONS
MICA
COLUMBIA
RIVER
ROCKY
MOUNTAINS
Golden
REVELSTOKE
Revelstoke
DUNCAN
Columbia Lake
Canal Flats
Kootenay River
Arrow Reservoir
Okanagan Lake
Okanagan River
Kettle
Penticton
Kootenay Lake
CORRA LINN
Nelson
Cranbrook
Fernie
HUGH KEENLEYSIDE
CANAL PLANT
BRILLIANT
Birchbank
MURPHY CREEK
Trail
WANETA
SEVEN MILE
BOUNDARY
CANADA
U.S.A.
Porthill
BOX CANYON
Pend Oreille R
Bonners Ferry
Kootenai R
Franklin D Roosevelt Lake
Okanogan R
Libby
LIBBY
COLUMBIA R
CHIEF JOSEPH
GRAND COULEE
0
Scale in Miles
50
Pacific Ocean
CANADA
USA
COLUMBIA R BASIN
COLUMBIA RIVER TREATY
PERMANENT ENGINEERING BOARD
POWER & STORAGE PROJECTS
NORTHERN COLUMBIA BASIN
SEPTEMBER 1988
PLATE NO. 1

TABLE 1

DUNCAN PROJECT

Duncan Dam and Duncan Lake

Storage Project	
Construction began	17 September 1964
Storage became fully operational	31 July 1967
Reservoir	
Normal Full Pool Elevation	1,892 feet
Normal Minimum Pool Elevation	1,794.2 feet
Surface Area at Full Pool	18,000 acres
Total Storage Capacity	1,432,500 ac-ft
Usable Storage Capacity	1,400,000 ac-ft
Treaty Storage Commitment	1,400,000 ac-ft
Dam, Earthfill	
Crest Elevation	1,907 feet
Length	2,600 feet
Approximate height above riverbed	130 feet
Spillway — Maximum Capacity	47,700 cfs
Discharge Tunnels — Maximum Capacity	20,000 cfs
Power Facilities	
None	

TABLE 2

ARROW PROJECT

Hugh Keenleyside Dam and Arrow Lakes

Storage Project	
Construction began	March 1965
Storage became fully operational	10 October 1968
Reservoir	
Normal Full Pool Elevation	1,444 feet
Normal Minimum Pool Elevation	1,377.9 feet
Surface Area at Full Pool	130,000 acres
Total Storage Capacity	8,337,000 ac-ft
Usable Storage Capacity	7,100,000 ac-ft
Treaty Storage Commitment	7,100,000 ac-ft
Dam, Concrete Gravity and Earthfill	
Crest Elevation	1,459 feet
Length	2,850 feet
Approximate height above riverbed	170 feet
Spillway — Maximum Capacity	240,000 cfs
Low Level Outlets — Maximum Capacity	132,000 cfs
Power Facilities	
None	

TABLE 3

MICA PROJECT

Mica Dam and Kinbasket Lake

Storage Project	
Construction began	September 1965
Storage became fully operational	29 March 1973
Reservoir	
Normal Full Pool Elevation	2,475 feet
Normal Minimum Pool Elevation	2,320 feet
Surface Area at Full Pool	106,000 acres
Total Storage Capacity	20,000,000 ac-ft
Usable Storage Capacity	
Total	12,000,000 ac-ft
Commitment to Treaty	7,000,000 ac-ft
Dam, Earthfill	
Crest Elevation	2,500 feet
Length	2,600 feet
Approximate height above foundation	800 feet
Spillway — Maximum Capacity	150,000 cfs
Outlet Works — Maximum Capacity	37,400 cfs
Power Facilities	
Designed ultimate installation	
6 units at 434 mw	2,604 mw
Power commercially available	December 1976
Presently installed	
4 units at 434 mw	1,736 mw
Head at full pool	600 feet
Maximum Turbine Discharge	
of 4 units at full pool	38,140 cfs

TABLE 4

LIBBY PROJECT

Libby Dam and Lake Koocanusa

Storage Project	
Construction began	June 1966
Storage became fully operational	17 April 1973
Reservoir	
Normal Full Pool Elevation	2,459 feet
Normal Minimum Pool Elevation	2,287 feet
Surface Area at Full Pool	46,500 acres
Total Storage Capacity	5,869,000 ac-ft
Usable Storage Capacity	4,980,000 ac-ft
Dam, Concrete Gravity	
Deck Elevation	2,472 feet
Length	3,055 feet
Approximate height above riverbed	370 feet
Spillway — Maximum Capacity	145,000 cfs
Low Level Outlets — Maximum Capacity	61,000 cfs
Power Facilities	
Designed ultimate installation	
8 units at 105 mw	840 mw
Power commercially available	24 August 1975
Presently installed	
5 units at 105 mw	525 mw
Head at full pool	352 feet
Maximum Turbine Discharge	
of 5 units at full pool	26,500 cfs